

What is claimed is:

1. A method for restoring a compressed image of an image processing system, comprising:

5 a step for defining a smoothing functional having a smoothing degree of an image and reliability for an original image by pixels having an identical property in image block units; and

10 a step for computing a restored image by performing a gradient operation on the smoothing functional in regard to the original image.

2. The method according to claim 1, wherein the step for defining the smoothing functional divides the pixels according to their position, horizontal direction, vertical direction and smoothing variation in a temporal section.

3. The method according to claim 1, wherein the smoothing functional $M(f)$ comprises a sum of a smoothing functional $M_{VB}(f)$ for pixels positioned at the boundary of a block in a vertical direction, a smoothing functional $M_{VW}(f)$ for pixels positioned inside the block in a horizontal direction, a smoothing functional $M_{HB}(f)$ for pixels positioned at the boundary of a block in a horizontal direction, a smoothing functional $M_{HW}(f)$ for pixels positioned inside the

block in a horizontal direction, and a smoothing functional $M_T(f)$ for pixels moved and compensated in the temporal section, "f" indicating the original image.

5 4. The method according to claim 3, wherein the smoothing functionals $M_{VB}(f)$, $M_{HB}(f)$, $M_{VW}(f)$, $M_{HW}(f)$, $M_T(f)$ are defined as;

10 $M_{VB}(f) = \|Q_{VB} f\|^2 + \alpha_{VB} \|g-f\|_{W1}^2$

$M_{HB}(f) = \|Q_{HB} f\|^2 + \alpha_{HB} \|g-f\|_{W2}^2$

$M_{VW}(f) = \|Q_{VW} f\|^2 + \alpha_{VW} \|g-f\|_{W3}^2$

$M_{HW}(f) = \|Q_{HW} f\|^2 + \alpha_{HW} \|g-f\|_{W4}^2$

$M_T(f) = \|Q_T f\|^2 + \alpha_T \|g-f\|_{W5}^2$

15 Q_{VB} , Q_{VW} , Q_{HB} , Q_{HW} , Q_T indicating high pass filters for smoothing the respective pixels, α_{VB} , α_{HB} , α_{VW} , α_{HW} , α_T being regularization parameters, g being a reconstructed image, and $W1$, $W2$, $W3$, $W4$, $W5$ indicating diagonal matrixes for determining whether each group has an element.

20 5. The method according to claim 1, wherein the step for computing the restored image comprises a step for approximating the regularization parameter by applying a set theoretic, and it is presumed that the quantization variables
25 of the DCT region are regular in each macro block, and also

presumed that the DCT quantization errors have the Gaussain distribution property in the spatial section.

6. The method according to claim 5, wherein the regularization parameters are approximated as;

$$\alpha_{VB} = \frac{\|Q_{VB}f\|^2}{\|g-f\|_{w1}^2} = \frac{\|Q_{VB}g\|^2}{\|g-f\|_{w1}^2} = \frac{\|Q_{VB}g\|^2}{\sum_{n,m} w_1(m,n) Qp^2(m,n)}$$

$$\alpha_{HB} = \frac{\|Q_{HB}f\|^2}{\|g-f\|_{w2}^2} = \frac{\|Q_{HB}g\|^2}{\|g-f\|_{w2}^2} = \frac{\|Q_{HB}g\|^2}{\sum_{n,m} w_2(m,n) Qp^2(m,n)}$$

$$\alpha_{VW} = \frac{\|Q_{VW}f\|^2}{\|g-f\|_{w3}^2} = \frac{\|Q_{VW}g\|^2}{\|g-f\|_{w3}^2} = \frac{\|Q_{VW}g\|^2}{\sum_{n,m} w_3(m,n) Qp^2(m,n)}$$

$$\alpha_{HW} = \frac{\|Q_{HW}f\|^2}{\|g-f\|_{w4}^2} = \frac{\|Q_{HW}g\|^2}{\|g-f\|_{w4}^2} = \frac{\|Q_{HW}g\|^2}{\sum_{n,m} w_4(m,n) Qp^2(m,n)}$$

$$\alpha_T = \frac{\|Q_Tf\|^2}{\|g-f\|_{w5}^2} = \frac{\|Q_Tg\|^2}{\|g-f\|_{w5}^2} = \frac{\|Q_Tg\|^2}{\sum_{n,m} w_5(m,n) Qp^2(m,n)}$$

$Q_p^2(m,n)$ indicating a quantization variable of a macro block including an (m,n)th pixel of a two-dimensional image.

6. The method according to claim 1, wherein a local minimizer of the smoothing functional is a global minimizer.

7. The method according to claim 1, wherein the regularization parameter indicates a ratio of a smoothing degree of the image and reliability for the original image.

8. The method according to claim 1, further comprising a step for computing an iterative solution in regard to a restored image, after computing the restored image.

9. The method according to claim 8, wherein the iterative solution f_{k+1} is represented by;

$$f_{k+1} = f_k + \beta [Ag - Bf_k],$$

$$A = \alpha_{VB}W_1 + \alpha_{HB}W_2 + \alpha_{VW}W_3 + \alpha_{HW}W_4 + \alpha_TW_5$$

$$B = (Q_{VB}^T Q_{VB} + Q_{HB}^T Q_{HB} + Q_{VW}^T Q_{VW} + Q_{HW}^T Q_{HW} + Q_T^T Q_T) + A$$

and, β is a relaxation parameter having a convergence property, and computed at the range of $0 < \beta < \frac{2}{1 + \max_i \lambda_i(A)}$, an eigen value $\lambda(A)$ of the matrix A being replaced by a fixed value.

10. The method according to claim 9, wherein a predetermined threshold value is set in computing an iterative

solution, an image obtained after iteration is compared with the previously-set threshold value, and it is determined whether the iteration technique is continuously performed according to a comparison result, or the iteration is finished after the iteration technique is performed as many as a previously-set number.

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12. The method according to claim 11, further comprising a step for obtaining a mapped image by projecting a two-dimensional DCT coefficient of the restored image corresponding to a computed iterative solution, and for performing an inverse DCT on the mapped image.

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13. The method according to claim 12, wherein the step for obtaining the mapped image is mapping a projected restored image $P(F_{k+1}(u,v))$ to $G(u,v) - Qp$ when the DCT coefficient of the restored image $F_{k+1}(u,v)$ is smaller than $G(u,v) - Qp$, mapping the projected restored image $P(F_{k+1}(u,v))$ to $G(u,v) + Qp$ when $F_{k+1}(u,v)$ is greater than $G(u,v) + Qp$, and otherwise mapping the projected restored image $P(F_{k+1}(u,v))$ as it is, $G(u,v)$ indicating a two-dimensional DCT coefficient obtained by performing the DCT on the reconstructed image, and Qp indicating quantization information.

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14. An apparatus for restoring a compressed image of an

image processing system, comprising:

a decoder for decoding a coded image signal, and for outputting information of the restored image, such as the decoded image, a quantization variable, a macro block type and a motion vector; and

a post processing unit for including the information of the restored image inputted from the image decoder, for defining a smoothing functional including a smoothing degree of the image and reliability of an original image by pixels having an identical property in image block unit, and for performing a gradient operation on the smoothing functional in regard to the original image,

the smoothing functional including a regularization parameter having weight of reliability for the original image.

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